PROMOTING GREEN TRANSPORTATION VIA PERSUASIVE GAMES

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It is now widely accepted that human behaviour accounts for a large portion of total global emissions, and thus influences climate change to a large extent (IPCC, 2014). Changing human behaviour when it comes to mode of transportation is one component which could make a difference in the long term. In order to achieve behavioural change, we investigate the use of a persuasive multiplayer game. Transportation mode recognition is used within the game to provide bonuses and penalties to users based on their daily choices regarding transportation. Preliminary results from testers of the game indicate that using games may be successful in causing positive change in user behaviour.

INTRODUCTION

This work presents an approach to change human behaviour by using persuasive serious games, where the intention is to evaluate if and how we can decrease our overall carbon footprint. More specifically, the work looks at changing behaviour when it comes to selecting modes of transportation. Transportation accounts for a large portion of our total emissions. According to Bin and Dowlatabadi (Bin & Dowlatabadi, 2005), 22% of total emissions stem from 'personal travel', of which 68% comes from direct usage and 32% from indirect influences. If we could influence our daily choices of transport, it could therefore have a significant impact on the total emissions.

As an example in Sweden, the overall emissions within the country have decreased over time, making it seem like a good role model for change. Nevertheless, when studying the emissions generated by Swedes due to consumption, the total emissions have in fact increased (Naturvårdsverket, 2017). Figure 1 shows the consumption-related emissions caused by Swedes. Labelled in the figure are 3 lines: *Emissions in Sweden,* which corresponds to consumption of domestic goods; *Emissions in other countries, which* includes emissions relating to imported goods; and *Total*, the sum of the two former lines. One can see in the figure that consumption-related emissions have decreased within Sweden by 30%, but increased by 50% outside of the country (due to increased import). The data presented there, however, is mostly calculated on consumption and investments of households, government and companies, and is not directly related to traffic-related emissions. Figure 2 shows, similarly, the emissions caused by Swedes in transit.

Nevertheless, in order to achieve change we have to consider all stages of change. Information is a key element to begin to contemplate change, and strong motivators are key elements for maintaining change. These elements are all prominent in games and gamification, and with

good design a game can make learning about sustainable transportation fun, as well as help users adopt and maintain a new, sustainable behaviour for choosing transportation.

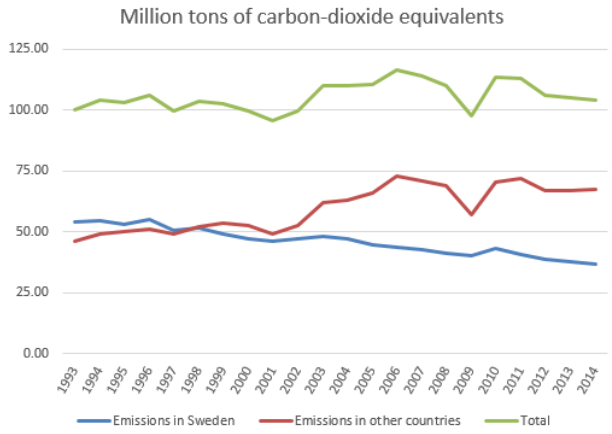

Figure 1, Consumption-based emissions by Swedes within and outside of Sweden in million tons of carbon-dioxide equivalents. (Naturvårdsverket, 2017)

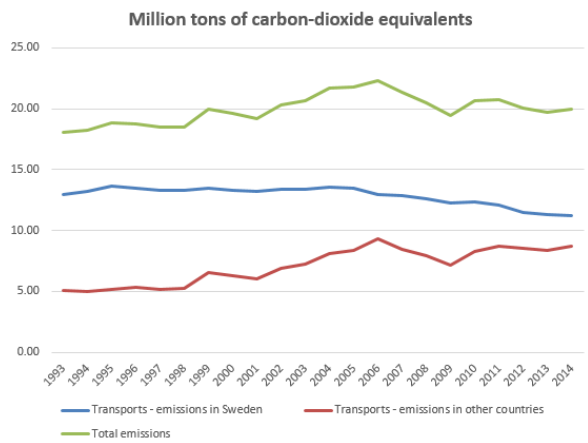

Figure 2, Emissions from transports by Swedes within and outside of Sweden. (Naturvårdsverket, 2017)

To build a convincing game, techniques from augmented reality and transport detection machine learning algorithms are used. The game has embedded multiplayer interactions, as this is often lacking in contemporary serious games.

Two of the main research questions posed at the start of this work were as follows:

- How well can we induce greener transportation choices by persuasive games?
- What aspects of persuasive games are impactful on transportation choices?

PERSUASIVE GAMES

Persuasive games, serious games and gamification are often aimed at health-related topics, such as exercise and healthy eating, or learning in general (Connolly, et al., 2012). Some other topics explored by persuasive games include smoking (Khaled, et al., 2007), views on homelessness (Lavender, 2006), and greening transportation (Froehlich, et al., 2009).

Khaled et al. (2007) discuss some of the difficulties in managing player attention, balancing the game contents with reality, and questions concerning identity and target audiences, as these impact the effects of persuasive games. Orji et al. (2013) analyse persuasive games and target players, and propose an approach to motivate players of certain gamer types with specific game mechanics.

Sebastian Deterding (2017), shows in his presentations and publications number of ways one can work towards persuading users. Some examples include constraints (making the unwanted impossible), default settings (to use the 'path of least resistance') and facilitation (easing change somehow, e.g. by making behaviour change relevant data visible). He also argues that games are good platforms for persuasive design as they are generally voluntary (already have intrinsic motivators for players to play the games), are generally prestructured

and have clear goals – while still fostering interesting interactions. Extrinsic motivators such as money and grades are generally proven to work well only in the short-term. For social multiplayer games, there are also social motivators such as recognition, belongingness, cooperation, competition, etc.

Ferrara (2013) argues that serious games and gamification can cause real change, but highlights that inattention to the quality of the player experience threatens its success. In effect, he argues that we should design games for change, rather than only applying specific gamification elements and hope that they achieve the same effect that a whole game does.

The project by Froelich et al. (2009) to promote greener transportation is interesting as it is one of few which have the same goal and setting as our work. In their work they combined a self-reporting system with a special pedometer and a dynamic graphic design to promote greener transportation. Among the many feedback participants gave, they suggested to use negative feedback as well as positive, to include more statistical figures of transport usage, and mentioned a discomfort of having to wear an extra sensor. The participants also appreciated visual stimuli, but requested diversity over time (as it only featured linear positive graphical progressions).

METHODOLOGY

The methodology is largely split into two parts: the design, testing and implementation of an appealing persuasive game, and methods for evaluation of the promotion of green transportation when employing the game with embedded transport-detection algorithms.

Persuasive Game Development

For game genre, a turn-based strategy and role-playing game hybrid was chosen. There are several reasons for this. Firstly, it enables an iterative approach to try and persuade players for each turn or day that they are playing the game. Secondly, players of role-playing games tend to play them for a long time, as long as they are well-designed. In the game, each turn would correspond to one real-life day. Actions in the real life (transports taken) would affect, to some extent, results in the game, and thus, give an incentive for players to choose greener modes of transportation later. Using a turn-based approach also makes it available to a larger audience, as less time is required to play it (a few minutes per turn or day), whereas a real-time game may distract and interfere with daily life. Pokémon Go is a great comparison as it is also in the same kind of genre, gathered a large popularity, caused a distinct change in behavioural patterns of players, but also has its disadvantages and hazards inherent in the game design (Serino, et al., 2016).

In the game, *daily actions* are chosen such as gathering food or materials, inventing and crafting weapons, armour and tools, building defences, scouting, interacting with other players, etc. The *daily actions* are then used as input for the game once each new turn is simulated. *Skills* are also chosen by players so that they may specialize and become better in one thing or another, to try and motivate cooperation. Some actions and skills were also competitive, such as stealing from or being able to attack other players. *Active actions* such as sending resources, items or messages between players can be performed whenever the

players want, to allow some flexibility and not only keep all actions being evaluated only when the turn ends.

Within the game there are some relevant statistics, with *emissions* being the most important one (affecting overall game difficulty) besides *hit points* (the standard statistic used to represent a character's vitality in many role-playing games). Different modes of transport give varying amounts of bonuses to the in-game *Daily actions*, as well as generating various amounts of *emissions*. Choosing specific actions within the game which consume resources (crafting, inventing, building defences) also increase the *emissions* statistics, while some actions and skills actively reduce or indirectly reduce future *emissions* generation.

To adhere to good game-development and software development practices, the development lifecycle was preceded with the development and evaluation of a paper prototype (Hedemalm, 2016). Testers of the paper prototype found the game interesting, after which a digital graphical prototype was developed (see figure 3).

Figure 3. Early design stages of the persuasive game titled Evergreen. Far left: First page of the initial paper prototype (11 pages in total). Middle-left: Early design of the game's splash-screen. Middle-right: early design of the game's main screen showing player statistics in the top, buttons for actions and a log of what has happened previously. Far right: early design of the results-screen, which is presented after each new day.

Using volunteer testers and the help of a graphics artist, an Android-based version of the game was developed. Figure 4 shows some screenshots of the game as it was published in social media.

Evaluating Behaviour Change

To evaluate potential behaviour change, one expectations questionnaire, as well as pre- and post-intervention questionnaires were given out to volunteers. The questionnaires were administered to testers before software development and testing began, as well as approximately 10 days after the testing period had started. Both quantitative and qualitative answers for each respondent was recorded, and additional interview questions were posed to all testers throughout and after the testing period to further evaluate both the game design as well as the potential impact on behaviour change.

Volunteers and participants for testing the game were mainly recruited over social media with no extra incentive added to play the game.

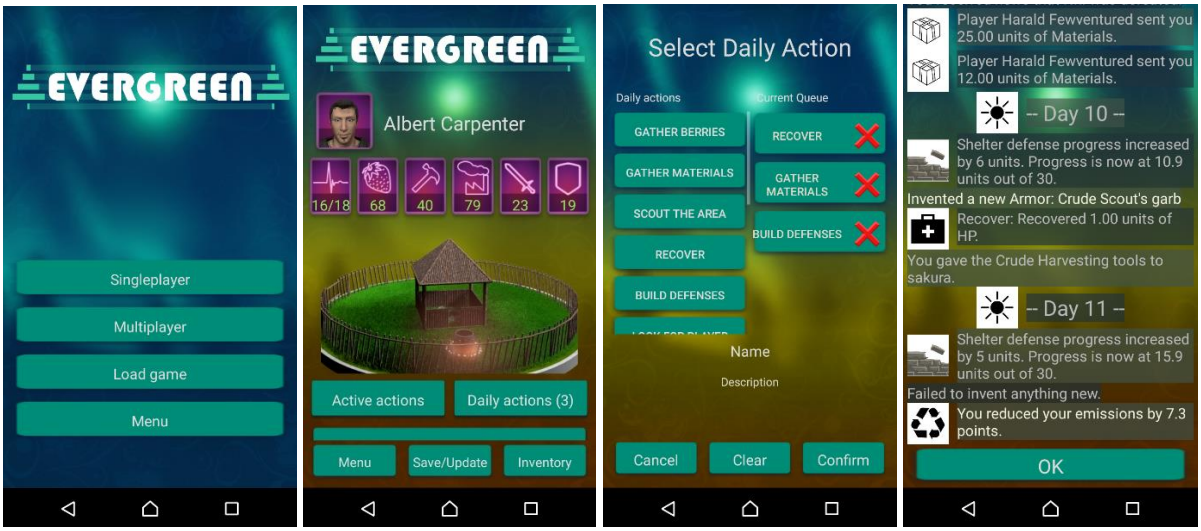

Figure 4. Screenshots from the Android version of the game Evergreen. Far left: splash-screen. Middle-left: Main screen, showing statistics in the top 6 icons. The background changes colour as emissions increase, and the representation of the shelter changes as it is being upgraded. Middle-right: 'Daily Actions' selection screen. Far-right: the results-screen showing what has happened the most recent days/turns.

RESULTS

The primary outcome of this research is a persuasive game, *Assaults of the Evergreen* or just *Evergreen*. Its official Facebook page with links to some relevant questionnaires can be found here: https://www.facebook.com/AssaultsOfTheEvergreen/

As for the questionnaires, the initial expectations-questionnaire got over 40 respondents, the pre-testing questionnaire received 24 respondents and for the game evaluation there were 4 testers who played the game in multiplayer mode for at least 10 days.

Respondents for the initial expectations-questionnaire were asked to which extent they thought a game could impact their lifestyle, if they were willing to play a game designed to improve their daily choice of transportation, and asked how they would imagine such a game would look like or be designed. A majority of the respondents had a background of playing digital games (Smartphone, Console or PC), and were of the opinion that games can have some impact on their lifestyles. Figure 5 shows response distribution for one of the questions, where 1 was labelled 'Not at all' and 5 was labelled 'A lot'.

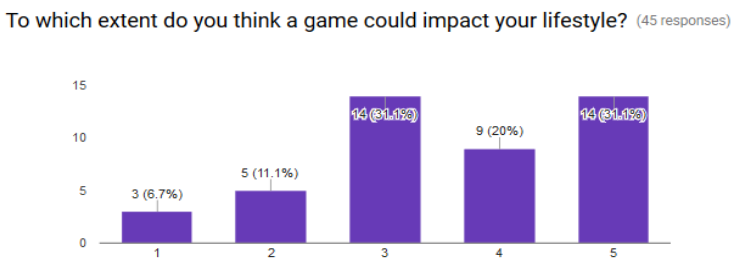

Figure 5. Expectations of how much a game can impact respondents' lifestyles

Responses to an open free-text question concerning how a persuasive game would be designed were diverse. Respondents suggested features such as showing real-life data and

personal statistics, adapting to players' personal schedules, and using notifications and achievements. Among the concerns were battery life, privacy of collected data (e.g. locational), and that the game not demand too much time from players. Some respondents said they would play any game if it was fun, while others stated that they wouldn't play the game to improve their daily choices since they already were using the greenest modes of transport (walking or biking). Some respondents also highlighted the social aspects, including competitions, and leader boards that may motivate players. One respondent mentioned that they would be more interested in features that help them choose greener modes of transport for a specific journey.

When asked how successful a persuasive game could be concerning transportation, some respondents underlined that the choice of transport is mostly one of practical nature: some distances and journeys are just not practical with greener modes of transport. One respondent recalled a long-term biking contest that was held at their workplace on a regular basis (weekly, monthly, yearly), and described that people participated mostly because of the competition (as part of the gamification) even though the website of the leader board was not very good. One respondent mentioned that even if the game is just entertainment for some players, it may encourage others to contemplate changes in their lifestyle. One respondent likened the concept to the success of Pokémon Go, claiming that it could be successful only by looking at how that game made players walk around everywhere. Some respondents mentioned that it all depends on the quality of the game and of the marketing: that any game can be successful if marketed well.

For the pre-testing questionnaire, respondents were asked in more detail who they are and their current habits. 15 men and 9 women responded, of varying ages (26-35) being the most common age-group. 11 were working full-time and 10 were students. 11 were recruited personally by us, while 13 were recommended to try out the game by a friend.

Similar to the results in the initial expectations-questionnaire, respondents of the pre-testing questionnaire had an overall positive view of the potential effects of a persuasive game such as *Evergreen*, as can be seen in figure 6. When responding to the question, the value 1 was labelled as 'No' and 5 as 'Yes', with respondents left to interpret the values in-between themselves.

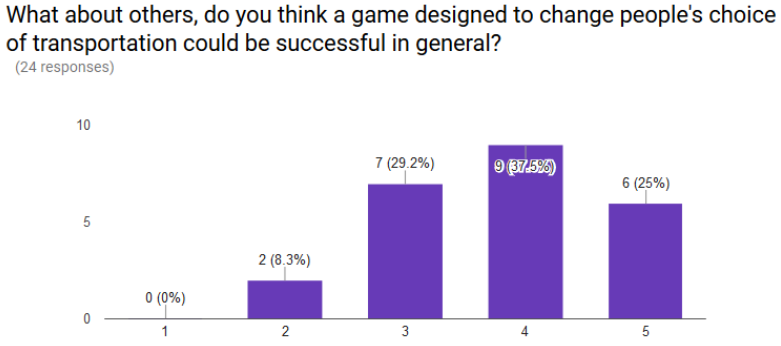

Figure 6. Respondents views on the potential success of persuasive games.

The four testers that played the game for at least 10 days each spent either 1-5 minutes or 6-10 minutes a day playing the game, and a similar amount of time talking about it with friends, colleagues or others. They generally thought the game was well-designed and well thought out, that it was generally not too hard to understand and play, and that it had enough character customization. Similarly, the testers generally thought the game had well-designed

graphics that made it easy to understand what was happening in the game and enjoyed playing the game.

Some criticism from the players included a lack of players to interact with and a lack of a tutorial (responses to the questionnaire were done assuming this will be added to a final version of the game). One player suggested that a more significant decrease of emissions should be added if the player was indeed walking or biking, and that there was too vague of a connection between transports chosen in the real world with consequences in-game. One player also suggested it needs more "in-your-face" pop-ups used in contemporary smartphone games.

Most players felt that their choice of transport was influenced to some extent while playing the game, where half of participants tried walking more than before, and one tried to drive cars less than before. When asked how much of their total traveling time was influenced, the answers were 0%, 5%, 10%, and 25% of total travelling time respectively between testers.

When asked why they were not influenced and what would have had an influence on their choices, one mentioned that the effects of actual transports did not really feel like it was reflected in the game. Another tester stated that while it made them more aware of their actions, other factors were still more important (distance, weather, time, etc). One participant mentioned that they need a car to get anywhere due to where they live, but that if they had lived closer to a city they would have walked or tried taking busses more often.

DISCUSSION

Persuasion as a tool to change people's behaviour has already been studied by many and persuasive games as a useful tool is still being explored. One key disadvantage is that the effects are possibly only short-term. Not so many persuasive games make use or focus on multiplayer interactions, however, and by analysing the responses from our questionnaires it seems that social factors such as competition would encourage more users to be persuaded to change their lifestyles. To answer the initial research questions:

- **How well can we induce greener transportation choices by persuasive games?**
  Travel time may be reduced by between 0 and 25% for participants, depending primarily on the participant's current living situation.
- **What aspects of persuasive games are impactful on transportation choices?**
  Using a game design based on iterative playing, highlighting co-operative and competitive interactions, and highlighting the impact of real-life vehicle usage within the game.

The testers of the game, *Assaults of the Evergreen*, were few but gave some insight into the possible effects of deploying such a game on a larger scale. Further testing of this game and similar games is suggested to verify if the potential behaviour changes would indeed come to realization or if they are merely expectations.

Due to the study being short-term, and few respondents played the game in multiplayer mode for the measured 10-day period, at this point only a hypothesis can be made on the possible

long-term effects and impacts a game such as *Evergreen* could have. Assuming *Evergreen* or a similar game gets popular and more than 5% of the Swedish population start playing it, and assuming an average behavioural change of 10% would be realized, then an estimated one hundred thousand tonnes of carbon dioxide equivalents could be saved each year. This is shown in equation 1, and is based on the Swedish transports emissions for the year of 2014, where Swedes emitted a total of 19.95 $MtCO^2$ from transportation alone (Naturvårdsverket, 2016). Seeing as the Swedish population has begun emitting more emissions internationally, however, such a game would have to properly identify and integrate transportation by plane. This figure also does not account for the increased battery usage from playing the game.

$$19.9522255\ MtCO^2\text{e}\ \times\ 0.05\ \times 0.10 = 99.7611275\ ktCO^2e \qquad (1)$$

What is worth noting is that even for those people who would not play Evergreen or a similar game for a long time, it could still have effects on the long-term.

Some future development of the game would include updates to the transport recognition and its effect in-game to diminish ambiguity, adding a tutorial, updating its design, and testing it with a larger set of players. With a large set of players and a longer study period, quantitative results could also be gathered on the detected transports and amount of time for each and study how the players' habits are changing over time.

CONCLUSION

We have presented a prototype persuasive game with multiplayer interactions, called *Assaults of the Evergreen*, embedded with a transportation detection algorithm to enable a feedback from real-life actions into the game. Quantitative and qualitative data was gathered by the help of questionnaires and interviews to measure the expectations and possible effects of deploying a persuasive game such as *Evergreen*. Preliminary results from the game-testers show that deploying persuasive games to promote greener transportation may be successful, but that it will vary depending on each individual's situation. Testers playing the game for at least 10 days stated that they were trying to choose greener forms of transportation between and 0 and 25% or their total travel time.

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